TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35.U.S.C. 371

EXPRESS MAIL LABEL No.	DATE
EK839859300US	07 AUGUST 2000

ATTORNEY'S DOCKET NO.
A33405 PCT USA

U.S. APPLICATION NO.
09/601695

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/00405	09 FEBRUARY 1999	18 FEBRUARY 1998

TITLE OF INVENTION
SCHEDULING MEANS FOR DATA SWITCHING APPARATUS

533 Rec'd PCT/PTO 07 AUG 2000

APPLICANT(S) FOR DO/EO/US
Paul Graham Howarth and Ian David Johnson

Applicant herewith submits to the United States Designated /Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(I).
4. [ ] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [ ] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [ ] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [x] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [x] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [x] Other items or information:

Copy of International Publication No. WO 99/43131 (incl. 7 pages spec, 1 sheet claims and 1 sheet of drawings)
International Search Report
International Preliminary Examination Report
PCT/IPEA/402
PCT/IB/304
PCT/IB/308
Verified Statement Claiming Small Entity Status

09/601695

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/00405	09 FEBRAURY 1999	18 FEBRUARY 1998

17. [X] The following fees are submitted:

CALCULATIONS PTO USE ONLY

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Basic National Fee (37 CFR 1.492(a)(1)-(5):

Neither international preliminary examination fee (37 CFR 1.482)

Nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO (1.492(a)(3)) $970.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO (1.492(a)(5) $840.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO(1.492(a)(2)) $690.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) (1.492(a)(1)) $670.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... $ 96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of $130.00 for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate	$	
Total Claims	8 -20=		X $ 18.00	$	
Independent Claims	1 -3=		X $ 78.00	$	
Multiple dependent claim(s) (if applicable)			+ $260.00	$	
			TOTAL OF ABOVE CALCULATIONS =	$ 840.00	
Reduction by ½ for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$ 420.00	
			SUBTOTAL =	$ 420.00	
Processing fee of $130.00 for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			+	$	
			TOTAL NATIONAL FEE =	$ 420.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property			+	$ 40.00	
			TOTAL FEES ENCLOSED =	$ 460.00	
				Amt. refunded	$
				charged	$

a. [X] A check in the amount of $ 420 & 40 to cover the above fees is enclosed.

b. [ ] Please charge our Deposit Account No. 02-4377 in amount of $___ to cover the above fees. A copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4377. A copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

BAKER BOTTS L.L.P.
30 Rockefeller Plaza
New York, New York 10112-4498

Signature Ronald B. Hildreth

8/7/00
Date

Registration No. 19,498

A33405 PCT USA - 072854.0112

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Paul Graham Howarth et al.
Serial No.	:	To be Assigned
Filed	:	To be Assigned
For	:	SCHEDULING MEANS FOR DATA SWITCHING APPARATUS

PRELIMINARY AMENDMENT

Assistant Commissioner of Patents

Washington, D.C. 20231

Sir:

Preliminary to the examination of the above-identified application, please make the following amendment to the claims:

In the Claims:

Amend the following claims:

1. (Amended) Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports, the scheduling means [being for] capable of processing a plurality of interconnection requests, each request requesting interconnection between a subset of said input ports and a subset of respective said output ports, and each request [being associated with] having a respective priority level (Pi) which [has] is one of a predetermined number of priority levels;

the scheduling means comprising:

determination means for determining a first set of said requests according to said respective priority levels; and

a first pipeline stage [(10)] for receiving said first set of requests and satisfying at least [some] one of the first set of requests;

[and characterized by further comprising:]

priority mixer means [(13)] for determining a further set of said requests, the further set [being composed of those] including requests of said first set which were not satisfied[,] and [of] requests [among] included in said plurality of requests which were not part of said first set [and which are of any of said priority levels]; and

an additional pipeline stage [(11)] for identifying requests in said further set which can be satisfied, and for satisfying the identified requests.

2. (Amended) Scheduling means according to claim 1 [in which] wherein said determination means at any time determines said first set of requests [to have] as having the same priority level[, which] and wherein said priority level is a selected priority level.

3. (Amended) Scheduling means according to claim 2 [in which] wherein the determination means varies the selected priority level with time, and wherein the proportion of time for which the selected priority level takes each of said predetermined number of priority levels [being according to] is a respective predetermined proportion of time.

4. (Amended) Scheduling means according to claim 1[, claims 2 or claims 3] further comprising [a] at least one further pipeline stage [(12)] receiving the requests not satisfied by the additional pipeline stage [(11)], [or a plurality of successive further pipeline stages, the] a first of the [successive] of at least one further pipeline stages receiving the requests not satisfied by the additional pipeline stage [(11)], and each of the other [successive] at least one further pipeline stages receiving the requests not satisfied by [the] a preceding further pipeline stage.

5. (Amended) Scheduling means according to claim 4 further comprising priority mixing means provided before any of said further pipeline stages[, for transmitting to that further pipeline stage additional ones of said request which have not been satisfied].

Amend claim 6, line 1, delete "any preceding claim" and insert --claim 7--.

7. (Amended) Scheduling means according to claim 6 [in which,] wherein upon receiving instructions specifying predetermined connections between [some] at least two of the ports, said data array (CV_i) is modified to include said predetermined connections[, whereby said pipeline stages only satisfying requests which are consistent with said predetermined connections].

Amend claim 8, line 1, delete "any preceding claims" and insert --claim 1--.

REMARKS

This amendment eliminates multiple dependency in the claims and puts claims 1-8, as amended , in proper U.S. format. No new matter is introduced by this amendment.

Respectfully submitted,

Marta E Delsignore

Ronald B. Hildreth
Patent Office Reg. No. 19,498

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Attorney Docket No. A 33405
PCT 33A

Applicant or Patentee	Paul Graham HOWARTH and Ian David JOHNSON
International Application No.:	PCT/GB99/00405
Filed:	February 9, 1999
Title:	Scheduling Means for Data Switching Apparatus

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(b)) INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9 (c) for purposes of paying reduced fees under section 41 (a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled described in:

[ ] the specification filed herewith
[X] International application no. PCT/GB99/00405
[X] filed February 9, 1999

I have not assigned, granted, conveyed or licensed except as shown in the attachment hereto and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9 (c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9 (d) or a nonprofit organization under 37 CFR 1.9 (e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

[ ] no such person, concern, or organization
[X] persons, concerns or organizations listed below*

FULL NAME: POWER X LIMITED
ADDRESS: Stafford Court, 145 Washway Road, Sale, Manchester M33 7PE, Great Britain

[ ] Individual [X] Small Business Concern [ ] Nonprofit Organization

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28 (b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

P.G Howarth.

Paul Graham Howarth

10 JULY 2000

Date

Ian David Johnson

10 JULY 2000

Date

Attorney Docket No. A 33405 PCT USA

Applicant or Patentee	Paul Graham HOWARTH and Ian David JOHNSON
International Application No.:	PCT/GB99/00405
Filed:	February 9, 1999
Title:	Scheduling Means for Data Switching Apparatus

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS [37 CFR 1.9 (f) AND 1.27 (c)] - SMALL BUSINESS CONCERN

I hereby declare that I am

[ ] the owner of the small business concern identified below :
[X] an official of the small business concern empowered to act on behalf of the concern identified below :

NAME OF CONCERN POWER X LIMITED

ADDRESS OF CONCERN Stafford Court, 145 Washway Road, Sale, Manchester M33 7PE, Great Britain

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18 and reproduced in 37 CFR 1.9(d), for purpose of paying reduced fees under Section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties control or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled

Scheduling Means for Data Switching Apparatus

by inventors Paul Graham Howarth and Ian David Johnson
described in

[ ] the specification filed herewith
[X] the application identified above
[ ] Application Serial No. filed
[ ] Patent No. , issued

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who could not qualify as a small business concern under 37 CFR 1.9(d) or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e). *Note: Separate verified

statements are required from each named person, concern, or organization having rights to the invention averring to their status as small entities [37 CFR 1.27].

FULL NAME
ADDRESS
[ ] INDIVIDUAL [ ] SMALL BUSINESS CONCERN [ ] NONPROFIT ORGANIZATION

FULL NAME
ADDRESS
[ ] INDIVIDUAL [ ] SMALL BUSINESS CONCERN [ ] NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this Application or Patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate [37 CFR 1.28(b)].

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING ..... ANTHONY NEIL PRYCE .....

TITLE OF PERSON OTHER THAN OWNER ..... COMPANY SECRETARY .....

ADDRESS OF PERSON SIGNING ..... STAFFORD COURT, 145 WASHWAY RD, SALE CHESHIRE, M33 7PE, ENGLAND.

SIGNATURE .....

DATE ... July 10th 2000

SCHEDULING MEANS FOR DATA SWITCHING APPARATUS

This invention relates to scheduling means for data switching apparatus for use in computer-controlled digital data switching systems.

Many types of data transmission apparatus are known, all having their own particular features and systems. In all cases the intention is to allow data switching and transmission to be achieved as rapidly as the apparatus will allow. It is common for data to be sent in "packets" consisting of a predetermined number of bits of data plus control information indicating certain parameters of the data or its mode of transmission.

In data switching apparatus having an number of users there may be a requirement at any one time to set up a number of different interconnections between input ports and output ports. In any form of switch there is a limit to the number of simultaneous interconnections that may be formed. The switch is operating at its greatest efficiency when the greatest possible number of interconnections is formed and switching apparatus frequently includes what may be termed "scheduling means" in order to achieve this maximum number of interconnections.

A good scheduling scheme needs to balance the potentially conflicting objectives of making sure that all output ports are connected where there are requests for a connection to that port (efficiency), that high priority traffic is serviced quickly (prioritisation) and that low priority traffic is not ignored (fairness). The present invention addresses all of these issues and may, for example, be used with the data switching apparatus described and claimed in our co-pending British patent application No. 9717412.2

Various types of scheduling means are known. For example, United States Patent No. 5,500,858 describes one form of scheduling means in which requests for interconnections are considered and satisfied using what are called "rotating priority iterative matching desynchronising scheduler units". The "priority" in this case refers to priority given to input and output ports at any given time so as to ensure that each port has a fair chance of having a connection requests satisfied. The U.S. Patent goes on to describe how the scheme could be extended to handle requests at multiple priority levels but the scheme described would lack fairness, that is low priority requests would be ignored

under heavy load conditions where only higher priority requests would be satisfied.

It is an object of the present invention to provide data switching apparatus which includes scheduling means operable to satisfy a greater number of requests for interconnections than has previously been possible under such circumstances.

According to the present invention there is provided scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports between which data having one of a predetermined number of priority levels is to be passed, which scheduling means includes a first pipeline stage operable to satisfy at least some of the requests for interconnections which are applied to the scheduling means, a priority mixer to which are applied those requests for interconnections which were not satisfied by the first pipeline stage together with requests of different priority levels and operable to select which of those requests should be further considered, and at least one further pipeline stage to which are applied said further requests and operable to satisfy such of those requests as are possible and were not satisfied by any preceding pipeline stage.

The present invention overcomes the problems associated with the known prior art by using existing types of scheduling units, (for example those described in U.S. Patents Nos. 5,500,858 and 5.267,235, though any scheduling means which operates as described herein may be used) but connecting them in a novel arrangement. The scheduling means to be described may, for example, be used with the data switching apparatus described and claimed in our co-pending British patent application No. 9717412.2.

The invention will now be described with reference to the accompanying drawing, which shows a schematic block diagram of one embodiment of the invention.

The drawing shows three pipeline stages 10 to 12, with a priority mixer 13 connected between pipeline stages 10 and 11. Input connections and output connections are provided to the various pipeline stages and the priority mixer as shown and the operation of the arrangement will be described below.

Each of the pipeline stages 10, 11 and 12 operates to receive input connection Request Vectors RVi at Priority level Pi and a

Connection Vector CVi. In response to these inputs the pipeline stage generates output signals Queue Return QRet, Request Vector out RVo, Priority out Po and Connection Vector out CVo. The Request Vectors are bit fields where each bit corresponds to a possible connection between one of the input ports and one of the output ports of the data switching apparatus. That is, if there are n input ports and m output ports, the Request Vectors will be n x m bits wide, where a bit that is set indicates that a connection is being requested from the corresponding input port to the corresponding output port, whilst a bit that is clear indicates that such a connection is not being requested at this time. The Priority fields Pi and Po indicate the priority of the connection being requested at input (RVi) and output (RVo) respectively. The connection requests from each input port are all of the same priority, though the connections requested from different input ports may be of different priorities. The Connection Vector signal CVo defines connections which are to be made by a switching matrix (not shown). They indicate which input port, if any, is to be connected to each output port of the data switching apparatus. The Queue Return signals Qret represent connection requests that cannot be satisfied. These requests are returned to the input queues of the data switching apparatus ready to be requested again. The operation performed by each pipeline stage is to consider the connection requests at RVi and satisfy as many of them as possible, adding details of each satisfied connection to any already present at CVi and presenting the combined set of connections at CVo. Since each input port and each output port may only be involved in one connection at any given time, any connection requests which involve an input port or output port which is already part of a satisfied connection request may no longer be satisfied within the present set of connections and so such requests are returned to the input queues (signal Qret), to be considered as part of a subsequent set of connections. The remaining connection requests (those for which the corresponding input and output ports are still available for connection) are presented at the RVo output of the pipeline stage in order for them to be considered by a subsequent pipeline stage. Any such requests at the output of the last pipeline stage 13 (where there is no subsequent pipeline stage to consider them) are returned to the input queues of the data switching apparatus, as with the Qret output.

Consider now the overall operation of the scheduling means described above. At the input to the first pipeline stage, 10 requests for connections RVi at a single priority level Pi are presented. The first pipeline stage 10 then attempts to satisfy as many of these requests as possible.Traffic of each priority level is presented to the first pipeline stage 10 at a frequency proportional to the required bandwidth allocation for that priority level. For example, high priority level requests could be presented 50% of the time if a 50% bandwidth allocation for high priority traffic was required. The proportions assigned to each priority level would depend on the application and would be assigned by the system administrator and be independent of the operation of the pipeline stage. A lookup table may be used to define the priorities for each priority level. If there is only a small number of requests at the priority Pi then the first pipeline stage 10 will not make many connections and most of the input and output ports will not be utilised within the set of connections created by this stage, nor will there be many connection requests outstanding at that priority level which may be satisfied by the remaining pipeline stages 11 and 12. For this reason, the priority mixer 13 is introduced between the first and second pipeline stages 10 and 11. Applied to priority mixer 13 are connection requests RV2i of priorities other than Pi, the priorities of the requests being denoted by P2i. The priority mixer 13 decides, for each input port, whether to pass on to the second pipeline stage 11 the requests RVi remaining at priority level Pi from the first pipeline stage 10 or the new requests RV2i. The decision is made on the basis of choosing whichever set of requests has the highest number of requests that could still be satisfied within the current Connection Vector CVi, taking into account which input and output ports are already used by satisfied connection requests. This leads to higher connectivity within the data switching apparatus than if only requests of a single priority were considered, that is it is more efficient. It also allows good performance for low priority traffic in the absence of any higher priority traffic, since the low priority requests may be presented at the second pipeline stage 11 via the priority mixer 13, regardless of how infrequently low priority requests are selected to be presented to the first pipeline stage 10. The Connection Vector output CVo of the

last pipeline stage 13 defines all the connections that are to be made by the data switching apparatus in the next cycle of operation.

Since mixing requests of different priorities at the second and subsequent stages of the scheduling means leads to greater efficiency, it might seem like a good idea to do the same at the first pipeline stage 10. However, the scheduling units that make up each pipeline stage

do not themselves take any account of the priority of each request, that is they treat all requests equally. Hence if requests of different priorities were presented to the first pipeline stage there would be no concept of priority at all within the scheduling means, since the low priority requests would compete equally with the high priority requests for connections. Thus it will be seen that the first pipeline stage provides prioritisation and fairness as defined above, whilst the subsequent pipeline stages provide efficiency.

Further pipeline stages may be added if it is felt that three stages are not able to provide sufficiently high efficiency of switch utilisation. There is a trade-off between switch utilisation (how many connection requests may be satisfied at any time) and latency (each pipeline stage takes time to operate), so that the number of pipeline stages required will depend upon what balance of these factors is required for a particular embodiment. In general, more pipeline stages are needed to create maximal sets of connections as the number of ports in the data switching apparatus increases. In addition, priority mixer elements may be placed between others of the pipeline units to further increase efficiency if desired.

Instances may occur when, for example, certain connections between input ports and output ports are to be retained for a period of time (static or permanent connections). Alternatively, it may be necessary at certain times to block specified input ports or output ports (during a period of system maintenance, for example). Similarly, it may be necessary at certain times to set up connections from one input port to more than one output port at the same time (multicast). All of these facilities may be incorporated into data switching apparatus which uses the scheduling means described above. This is done by connecting appropriate logic to the inputs of the first pipeline stage 10 and/or the priority mixer 13. For instance, to create a permanent connection between an input port and an output port, the CVi input of the first pipeline stage 10 could be preset to indicate the required connection(s) rather than having all of its bits clear (indicating no pre-existing connections). Input and output ports may be blocked by masking off the appropriate bits of the RVi input of the first pipeline stage 10 and the RV2i input of the priority mixer 13. Multicast connections may be made in the same way as permanent connections, except that more than one

output port is set up to be connected to the desired input port. In all of these cases, the scheduling means works around the existing connections or blocked ports, making whatever connections it can between the remaining unconnected and non-blocked input and output ports.

CLAIMS

1. Scheduling means for data switching apparatus having a plurality of input ports and a plurality of output ports, the scheduling means being for processing a plurality of interconnection requests, each request requesting interconnection between a subset of said input ports and a subset of respective said output ports, and each request being associated with a priority level (Pi) which has one of a predetermined number of priority levels;

the scheduling means comprising:

determination means for determining a first set of said requests according to said respective priority levels; and

a first pipeline stage (10) for receiving said first set of requests and satisfying at least some of the first set of requests;

and characterized by further comprising:

priority mixer means (13) for determining a further set of said requests, the further set being composed of those requests of said first set which were not satisfied, and of requests among said plurality of requests which were not part of said first set and which are of any of said priority levels; and

an additional pipeline stage (11) for identifying requests in said further set which can be satisfied, and for satisfying the identified requests.

2. Scheduling means according to claim 1 in which said determination means at any time determines said first set of requests to have the same priority level, which is a selected priority level.

3. Scheduling means according to claim 2 in which the determination means varies the selected priority level with time, the proportion of time for which the selected priority level takes each of said predetermined number of priority levels being according to a respective predetermined proportion.

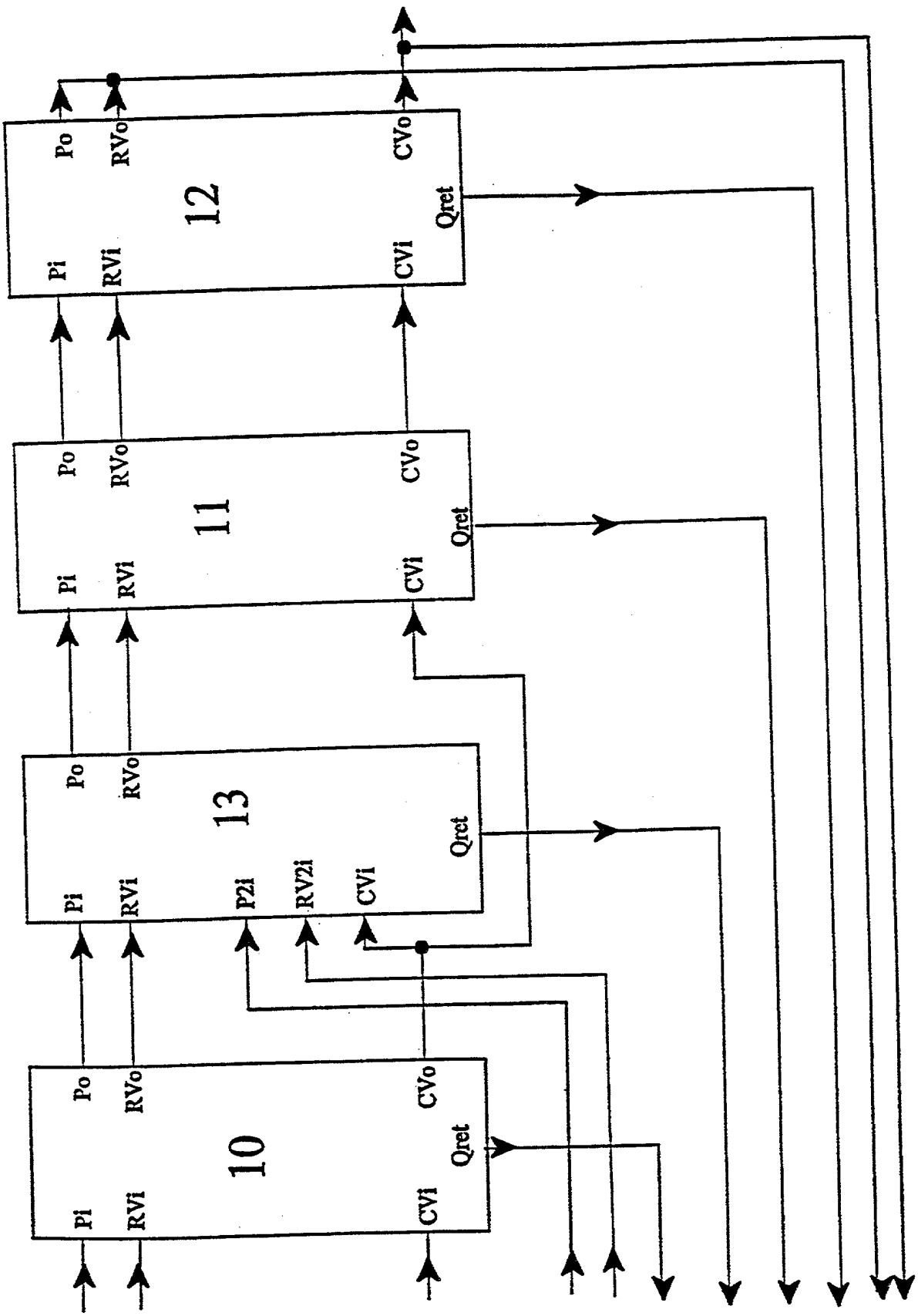
4. Scheduling means according to claim 1, claim 2 or claim 3 further comprising a further pipeline stage (12) receiving the requests not satisfied by the additional pipeline stage (11), or a plurality of successive further pipeline stages, the first of the successive further pipeline stages receiving the requests not satisfied by the additional pipeline stage (11), and each of the other successive further pipeline stages receiving the requests not satisfied by the preceding further pipeline state.

5. Scheduling means according to claim 4 further comprising priority mixing means provided before any of said further pipeline stages, for transmitting to that further pipeline stage additional ones of said requests which have not been satisfied.

6. Scheduling means according to any preceding claim which employs a data array (CV_i, CV_o) defining connections, said pipeline stage satisfying said requests by modifying said data array.

7. Scheduling means according to claim 6 in which, upon receiving instructions specifying predetermined connections between some of the ports, said data array (CV_i) is modified to include said predetermined connections, whereby said pipeline stages only satisfying requests which are consistent with said predetermined connections.

8. Scheduling means according to any preceding claim, further comprising means which, upon receiving instructions to inhibit connections to or from any of the input or output ports, modifies the inputs to the first pipeline stage and priority mixer to prevent connections to or from said inhibited ports.


12
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COMBINED DECLARATION AND POWER OF ATTORNEY A 33405 PCT USA

(Original, Design, National Stage of PCT, Divisional, Continuation or C-I-P Application)

As a below named inventor, I hereby declare that :
My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled :

This declaration is of the following type :

[ ]	original	[ ]	divisional
[ ]	design	[ ]	continuation
[X]	national stage of PCT	[ ]	continuation-in-part (C-I-P)

the specification of which : *(complete (a), (b) or (c))*

(a) [ ] is attached hereto.
(b) [ ] was filed on as Application No. and was amended on *(if applicable)*.
(c) [X] was described and claimed in PCT International Application No. PCT/GB99/00405 filed on February 9, 1999 and was amended on February 14, 2000 *(if applicable)*.

Acknowledgement of Review of Papers and Duty of Candor

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the patentability of the subject matter claimed in this application in accordance with Title 37, Code of Federal Regulations § 1.56.

[ ] In compliance with this duty there is attached an information disclosure statement. 37 CFR 1.98.

Priority Claim

I hereby claim foreign priority benefits under Title 35, United States Code, § 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT International Application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT International Application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application on which priority is claimed

(complete (d) or (e))

(d) [ ] no such applications have been filed
(e) [X] such applications have been filed as follows :

PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO SAID APPLICATION				
COUNTRY	APPLICATION NO.	DATE OF FILING (day, month, year)	DATE OF ISSUE (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Great Britain	9803301.2	18/02/98		[X] YES NO [ ]
				[ ] YES NO [ ]
				[ ] YES NO [ ]
ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS (6 MONTHS FOR DESIGN) PRIOR TO SAID APPLICATION				
				[ ] YES NO [ ]
				[ ] YES NO [ ]
				[ ] YES NO [ ]

Claim for Benefit of Prior U.S.A Provisional Application(s)

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below :

Provisional Application Number	Filing Date

Claim for Benefit of Earlier U.S./PCT Application(s) under 35 U.S.C. 120

(complete this part only if this is a divisional, continuation or C-I-P application)

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose information as defined in Title 37, Code of Federal Regulations, § 1.56 which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application :

(Application Serial No.) (Filing Date) (Status) (patented, pending, abandoned)

(Application Serial No.) (Filing Date) (Status) (patented, pending, abandoned)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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